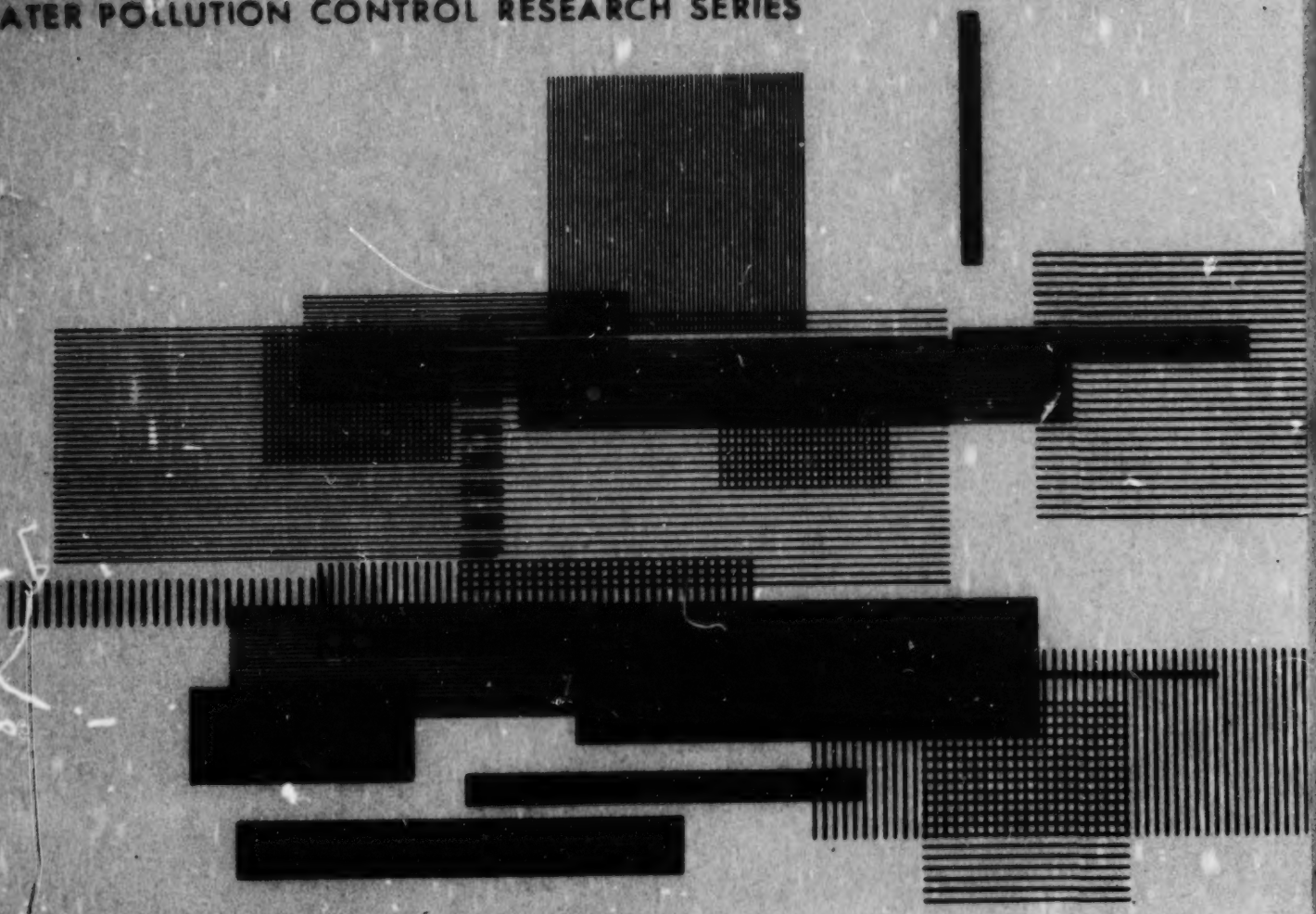
PB 182159

Executive Digital Computer Program for Preliminary Design of Wastewater Treatment Systems

WATER POLLUTION CONTROL RESEARCH SERIES



U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

WP-20-14

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EXECUTIVE

DIGITAL COMPUTER PROGRAM

FOR

PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTEMS

Robert Smith
Richard G. Eilers
Ella D. Hall

U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Advanced Waste Treatment Branch, Division of Research
Cincinnati Water Research Laboratory
Cincinnati, Ohio
August 1968

In its assigned function as the Nation's principal natural resource agency, the United States Department of the Interior bears a special obligation to ensure that our expendable resources are conserved, that renewable resources are managed to produce optimum yields, and that all resources contribute their full measure to the progress, prosperity, and security of America -- now and in the future.

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Water Pollution Control Research Series Publication No. WP-20-14

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INTRODUCTION

A digital computer program which can be used to compute the quasi-steady-state performance and cost of groups of conventional wastewater treatment processes arranged in any configuration has been developed at the Cincinnati Water Research Laboratory of the Federal Water Pollution Control Administration, U. S. Department of the Interior. This executive or calling program contains a Main program and ten subroutines, each of which computes the performance and cost of a single wastewater treatment process. Two additional subroutines are provided. The first, entitled COST sums the cost of the individual processes, adds engineering cost, contractor's profit, contingencies and omissions, and cost of land. The second subroutine entitle PRINT simply prints all pertinent data in a format which is described below under PRINT FORMAT. The ten processes included in the program together with the subroutine names are listed below:

Process Name	Subroutine Name
Preliminary Treatment	PREL
Primary Settler	PRSET
Aerator-Final Settler	AERFS
Mixer	MIX
Splitter	SPLIT
Digester	DIG
Vacuum Filter	VACF
Sludge Thickener	THICK
Sludge Elutriation	ELUT
Sludge Drying Beds	SBEDS

A listing of the entire FORTRAN IV program, a sample printout, and coding forms designed for preparing input to the program are included in the Appendix.

Federal Water Pollution Control Administration sponsored work is now underway to provide subroutines for additional wastewater treatment processes. Within the next year subroutines for the following processes should be completed:

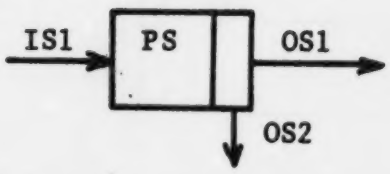
1. Trickling Filter
2. Final Clarifier for Activated Sludge Process
3. Fluidized Bed Incineration of Sludges
4. Coagulation and Sedimentation of Secondary Effluent following addition of lime or alum
5. Ammonia Stripping of Secondary Effluent
6. Granular Carbon Adsorption
7. Ion Exchange
8. Electrodialysis
9. Reverse Osmosis

Two engineering analysis projects which are now underway will provide better estimates of construction cost and operating and maintenance cost. Several large measurement programs are in progress which will supply better empirical design data for secondary processes.

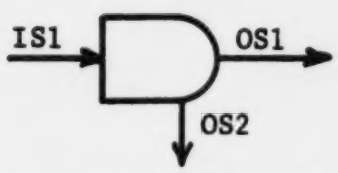
The first step in using the program is to draw the process diagram showing the processes to be used and the connecting and recycle streams. For this purpose, the process symbols shown in Figure 1 are suggested. Example process diagrams are shown in Figure 2. Each process and each stream is assigned a number. The principal influent stream to the system is always assigned the

PROCESS SYMBOLS

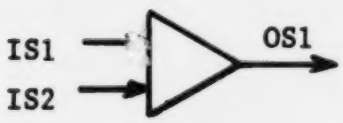
Preliminary Treatment



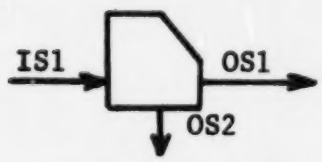
Primary Sedimentation



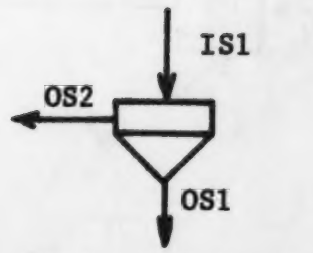
Aerator and Final Settler



Mixer

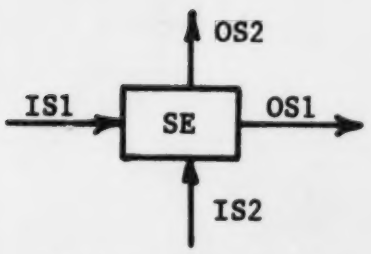


Vacuum Filter

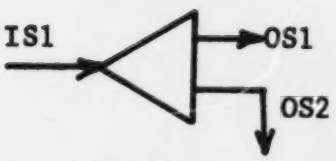


Sludge Thickener

Digester



Sludge Elutriation

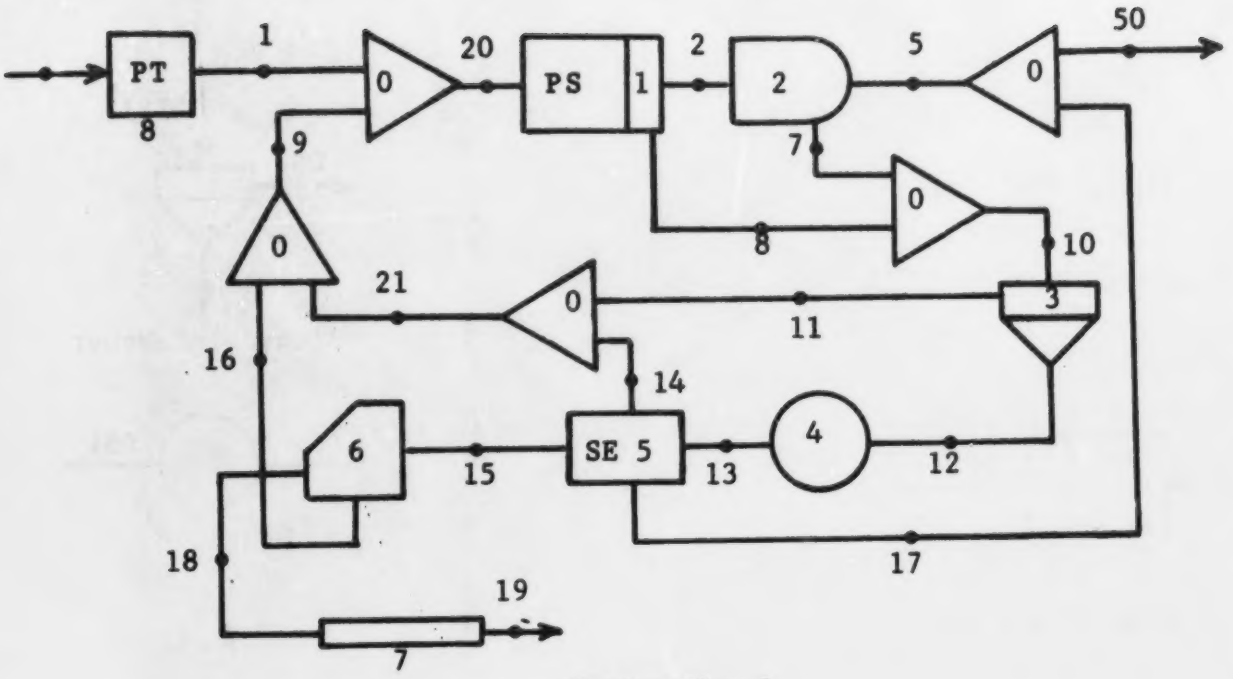


Splitter

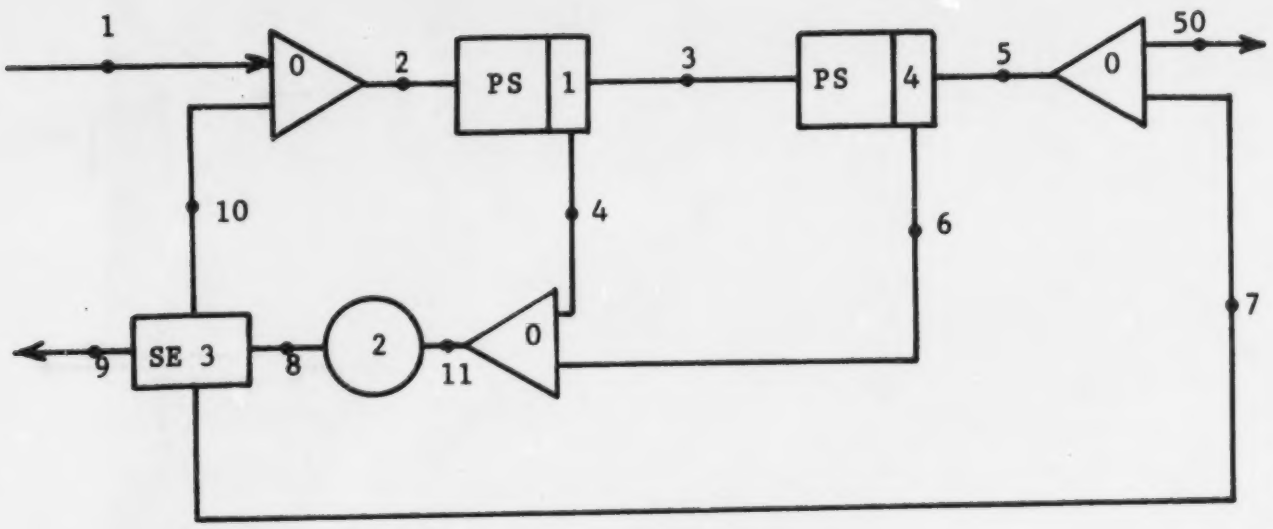
Sludge Drying Beds

Figure 1

EXAMPLE PROCESS DIAGRAMS



System No. 1



System No. 2

Figure 2

number one (1) and the principal effluent stream from the system is always assigned the number fifty (50). The number zero (0) is given to processes involving no cost or decisions such as the mixer or the splitter. Notice that the volume of the split stream must be supplied by some downstream process.

PROGRAM DESCRIPTION

The program provides for initially reading in any number (NIS) of influent and guess streams. All stream vectors are stored in the stream matrix (SMATX) which has 20 rows and 50 columns. One stream vector is stored in each column of SMATX. A temporary stream matrix (TSMATX) with 20 rows and 50 columns is also provided to store newly computed stream vectors until they can be compared with the previously computed values. The error (EPS) which will be tolerated when recycle streams are involved is also supplied as input to the program. The value for EPS normally used in the program is 0.10 mg/1. Each stream is described by the stream number in the first row of SMATX, the volume flow in millions of gallons per day in the second row, and the concentration of fifteen contaminants in rows 3-17. A list of information contained in the stream vector is shown on the next page with the FORTRAN variable names used.

Row No.	Descriptive Parameter	FORTRAN Variable Names
1	Stream Number	SMATX(1,I)*I
2	Volume Flow, mgd	SMATX(2,I),Q
3	Solid Organic Carbon, mg/l	SMATX(3,I),SOC
4	Solid Nonbiodegradable Carbon, mg/l	SMATX(4,I),SNBC
5	Solid Organic Nitrogen, mg/l	SMATX(5,I),SON
6	Solid Organic Phosphorus, mg/l	SMATX(6,I),SOP
7	Solid Fixed Matter, mg/l	SMATX(7,I),SFM
8	Solid BOD, mg/l	SMATX(8,I),SBOD
9	Volatile Suspended Solids, mg/l	SMATX(9,I),VSS
10	Total Suspended Solids, mg/l	SMATX(10,I),TSS
11	Dissolved Organic Carbon, mg/l	SMATX(11,I),DOC
12	Dissolved Nonbiodegradable Carbon, mg/l	SMATX(12,I),DNBC
13	Dissolved Nitrogen, mg/l	SMATX(13,I),DN
14	Dissolved Phosphorus, mg/l	SMATX(14,I),DP
15	Dissolved Fixed Matter, mg/l	SMATX(15,I),DFM
16	Alkalinity, mg/l	SMATX(16,I),ALK
17	Dissolved BOD, mg/l	SMATX(17,I),DBOD
18	Unassigned	
19	Unassigned	
20	Unassigned	

* I designates the stream number

A decision matrix (DMATX) is provided with 16 rows and 20 columns for storing design parameters such as overflow rates, solids loading rates, or operating mode decisions such as mixed liquor suspended solids concentration in the aerator or the BOD to be achieved in the principal effluent stream. Decision parameters for the Nth process are stored in the Nth column of DMATX. Column 20 of DMATX is reserved for cost parameters which apply to all processes. Row 16 (or additional rows if required) of DMATX are reserved for the excess capacity factor (ECF) which is a multiplier on the size of the process to allow for shutdown for cleaning and maintenance. A list of the contents of DMATX is shown in Table I. For processes having a process number (N) the contents of the Nth column of DMATX are read in from two cards which follow the process card for the Nth process. For the mixer and splitter no process number is assigned, or the number zero is given, and the two cards containing decision parameters are omitted.

The executive program is entitled MAIN and has the function of calling the ten subroutines for computing the performance of individual processes in the proper order. When recycle loops occur this involves recomputing all of the processes within the recycle loop in an iterative manner until each element of all stream vectors involved cease to vary by more than the prescribed tolerance (EPS).

A description of the system configuration, that is, the processes to be used and the location of the interconnecting streams is communicated to the computer by a stack of process cards. One card is used for each process. The name of the process is punched in columns 7-12 as shown in the attached coding forms (Sheets 2 and 3). The number of the principal

Table I

CONTENTS OF DECISION MATRIX (DMATX)

Aerator-Final Settler

DMATX(1,N) = BOD of OS1
DMATX(2,N) = MLSS
DMATX(3,N) = DEGC
DMATX(4,N) = CAER20
DMATX(5,N) = DO
DMATX(6,N) = AEFF20
DMATX(7,N) = URSS
DMATX(8,N) = GSS
DMATX(13,N) = ECF4 (Final Settler)
DMATX(14,N) = ECF3 (Sludge Return Pump)
DMATX(15,N) = ECF2 (Blowers)
DMATX(16,N) = ECF1 (Aerator)

Primary Settler

DMATX(1,N) = FRPS
DMATX(2,N) = URPS
DMATX(16,N) = ECF

Digester

DMATX(1,N) = TD
DMATX(2,N) = TDIG
DMATX(16,N) = ECF

Thickener

DMATX(1,N) = TRR
DMATX(2,N) = TSS of OS1
DMATX(3,N) = GTH
DMATX(4,N) = GSTH
DMATX(16,N) = ECF

Elutriation

DMATX(1,N) = ERR
DMATX(2,N) = TSS of OS1
DMATX(3,N) = WRE
DMATX(4,N) = GE
DMATX(5,N) = GES
DMATX(16,N) = ECF

Vacuum Filtration

DMATX(1,N) = VFL
DMATX(2,N) = TVF
DMATX(3,N) = TSS
DMATX(16,N) = ECF

Sludge Drying Beds

DMATX(1,N) = SBL
DMATX(16,N) = ECF

Cost Constants, Column 20

DMATX(1,20) = CKWH
DMATX(2,20) = CCI
DMATX(3,20) = AF
DMATX(4,20) = CTRP
DMATX(5,20) = CTGO
DMATX(6,20) = CLAND
DMATX(7,20) = CFECL3
DMATX(8,20) = CCL2

input stream to the process (IS1) is punched in columns 20 and 21. If a second input stream exists the number of the stream (IS2) is punched in columns 30 and 31. The principal output stream from the process (OS1) is punched in columns 40 and 41. If a second output stream exists the number (OS2) is punched in columns 50 and 51. Notice that the principal input and output streams must correspond to the designation shown in Figure 1.

The order in which the processes are computed is determined by the integer (K) punched in column one and the integer (III) punched in column 80. K is the loop number and it can be assigned any number from 1-9. The first and last processes to be computed in a recycle loop are marked with the same loop number (K) in column one. Recycle loops within recycle loops are allowed but each loop must be assigned a unique loop number.

The integer (III) is used to identify primary loops, that is, loops which are not inside of any other loop. The first and last process of primary loops are marked by the integer (1) in the 80th column. Processes which are not part of any recycle loop are marked with the integer (2) in the 80th column.

A list of the process cards are printed as part of the output format. The process cards for the two systems shown in Figure 1 are listed in Table II.

USE OF CODING FORMS

Three coding forms, Sheets 1, 2, and 3, have been designed for preparing input data to the program. These are found in the Appendix. Sheet 1 contains the description of the influent and guess streams. The number of streams read in cannot exceed ten. The number of input streams (NIS) to be read is punched in the first four columns of the card. The stream numbers

Table II

INPUT DATA System No. 1

K	N	PROCESS	IS1	IS2	OS1	OS2	III
0	7	PREL	1	0	3	0	2
1	0	MIX	3	9	20	0	1
0	1	PRSET	20	0	2	8	0
0	2	AERFS	2	0	5	7	0
0	0	SPLIT	5	0	50	17	0
0	0	MIX	7	8	10	0	0
0	3	THICK	10	0	12	11	0
0	4	DIG	12	0	13	0	0
0	5	ELUT	13	17	15	14	0
0	6	VACF	15	0	18	16	0
0	0	MIX	11	14	21	0	0
1	0	MIX	16	21	9	0	1
9	0		0	0	0	0	0

INPUT DATA System No. 2

K	N	PROCESS	IS1	IS2	OS1	OS2	III
1	0	MIX	1	10	2	0	1
2	0	MIX	1	10	2	0	0
0	1	PRSET	2	0	3	4	0
0	0	MIX	4	6	11	0	0
0	2	DIG	11	0	8	0	0
2	3	ELUT	8	7	9	10	0
0	0	SPLIT	5	0	50	7	0
1	4	PRSET	3	0	5	6	1
9	0		0	0	0	0	0

are then read in (in the order they will appear) as elements of the NN vector. The flow and concentrations of the first, second, third, etc., streams are then read in using F10.3 fields. The tolerance (EPS) to be used for recycle iteration is read in with a F10.3 field on the first card.

The next group of data to be read in (Sheet 2) contains general cost information. These data are read into the 20th column of the decision matrix (DMATX). Definitions of these terms can be found in Table A-1 of the Appendix.

Process cards are prepared next (using Sheets 2 and 3) with the two decision cards following each process card unless the process is zero. The parameters shown on the decision cards will correspond to the process named on the process card; see Table I. After one process card and two decision cards have been prepared for each process in the system and they have been arranged in the correct order, the input deck is terminated with a card in which a (9) has been punched in the first column. This card is important because it indicates end of file.

PRINT FORMAT

The first group of output printing shows the process cards which describe the wastewater treatment system which was computed. As each subroutine is computed the name of the subroutine is printed. These statements can be removed from the deck if this information is not required. The third group of data shows the volume flow and concentrations of fifteen contaminants in each numbered stream. The stream is identified by the letter (S) followed by the stream number in the left-hand column of the printout. For example, stream number 3 is identified by (S 3).

The fourth set of output lists the processes according to process number (P 2) and gives the name of the process with all pertinent parameters relating to the process. The capital cost for the process is given in thousands of dollars. The operating and maintenance cost, the amortization cost, and the total treatment cost are given for each process in cents per thousand gallons of water treated. The flow used here is always that of the influent stream designated as stream number one. The fifth set of printout shows the general cost items such as the capital cost index (CCI), the amortization factor (AF), the cost of engineering (ENG), contractors profit (CTRP), contingencies and omissions (CTGO), and land (CLAND). The total capital cost of the sytem is given in thousands of dollars. The total amortization cost, operating and maintenance cost, and total treatment cost for the system are given in cents per 1000 gallons of water treated.

Detailed discussion of the bases for the individual process models can be found in the following FWPCA Report No. WP-20-9:

Preliminary Design and Simulation of Conventional Wastewater Renovation Systems Using the Digital Computer

by

Robert Smith

APPENDIX

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Table A-1 VARIABLES AND PARAMETERS USED IN COST-PERFORMANCE COMPUTATION

Text Symbols	Computer Symbols	Nominal Value	Definitions and Comments
	ACOST(j)		Amortization cost for the jth process, dollars per year.
	AE		Surface area of elutriation tank, sq. ft.
AEFF	AEFF		Efficiency of diffusers in aerator corrected for water temperature and dissolved oxygen deficit.
$AEFF_{20}$	AEFF20	0.075	Efficiency of diffusers in aerator at zero dissolved oxygen and $20^{o}C$.
	AF	0.0736	Vacuum filter area, sq. ft.
	AFS		Surface area of final settler, sq. ft./1000.
AIRCFD	AIRCFD		Air requirements for aerator in standard cubic feet per day.
ALK_i	ALK(i)		Concentration of alkalinity as $CaCO_3$ at Station No. 1, mg/l[a].
	AOCOST(j)		Sum of operating and amortization cost for the jth process, dollars per year.
APS	APS		Surface area of primary settler, sq. ft./ 1000.
	ASB		Area of sludge drying beds, sq. ft.
	ASMAX		Current maximum value of MLASS, mg/l mass.
	ASMIN		Current minimum value for MLASS, mg/l mass.
	ASS(i)		The ith input value for MLSS.
	ASS(k)		Input values for mixed liquor suspended solids to be held in the aerator.
	ATH1		Surface area of thickener based on overflow rate, sq. ft.
	ATH2		Surface area of thickener based on solids loading rate, sq. ft.

[a] mg/l = milligrams per liter.

Table A-1 VARIABLES AND PARAMETERS USED IN COST-PERFORMANCE COMPUTATION (Cont.)

Text Symbols	Computer Symbols	Nominal Value	Definitions and Comments
	ATHM		Greater value of ATH1 and ATH2, sq. ft.
	AVF		Area of vacuum filter, sq. ft.
	BODI		Total BOD[a] at Station No. I, mg/l oxygen.
	BODREM		Fractional 5-day BOD removal across aerator.
	BSIZE		Required size of blower for supplying air to aerator, cubic feet per minute.
$CAER_{20}$	CAER20	1.0	Rate constant used for sizing the aerator when water temperature is 20°C.
CAER	CAER		Rate constant for sizing aerator corrected for water temperature.
	CAIRP		Cost of electrical power for operating blowers, dollars per year.
	CCI	1.25	Capital cost index to account for the variation of construction cost with time.
	CCOST(j)		Capital cost of the jth process in dollars.
	CEDR	0.18	Rate at which active solids are destroyed by natural causes in the aerator, fraction/day mass.
	CFECL3	0.08	Cost of ferric chloride for treating washed sludge, dollars per pound.
	CFPGAL		Air requirement for aerator, scf[b]/gallon of sewage at Station No. 1.
	CH4CFD		Standard cubic feet of methane produced in the digester each day, scf/day methane.
	CKWH	0.01	Cost of electrical power, dollars/kilowatt-hour.

[a] BOD = Biochemical Oxygen Demand.

[b] scf = Standard cubic feet.

Table A-1 VARIABLES AND PARAMETERS USED IN COST-PERFORMANCE COMPUTATION (Cont.)

Text Symbols	Computer Symbols	Nominal Value	Definitions and Comments
	CNIT		Rate constant used in nitrification calculation.
	CO2CFD		Standard cubic feet of carbon dioxide produced in the digester each day, scf/day CO_2.
	COSTO(i)		Operating cost for the ith process, dollars/year.
	COSTO(j)		Operating cost for the jth process, dollars/year.
	CPERKG(i)		Total cost of the ith process, cents/1000 gal.
	CREM		Fraction of organic carbon removed across the aerator.
K_1	C1DIG	0.25	Rate constant for digester.
K_2	C2DIG	447.5	Rate constant for digester.
	CWR		Carbon waste ratio, ratio of carbon in waste stream (Station 7) to carbon in influent stream (Station 2), (lb/day)/(lb/day).
$DBOD_1$	DBOD(1)		Dissolved BOD at Station No. 1.
	DBOD(4)		Dissolved unmetabolized 5-day BOD in aerator, mg/l[a] oxygen.
T	DEGC	20.0	Water temperature, degrees Centigrade.
	DEMBOD(i)		The ith input value for BOD_5.
	DEMBOD(k)		Input values for demand value of 5-day BOD at Station No. 5.
DFM_1	DFM(i)		Dissolved inorganic species at Station No. 1, mg/l mass.
$DIGC_{12}$	DIGC12		Concentration of biodegradable carbon at Station 12, mg/l carbon.

[a] mg/l = milligrams per liter.

Table A-1 VARIABLES AND PARAMETERS USED IN COST-PERFORMANCE COMPUTATION (Cont.)

Text Symbols	Computer Symbols	Nominal Value	Definitions and Comments
$DIGC_{13}$	DIGC13		Concentration of biodegradable carbon at Station 13, mg/l[a] carbon.
DN_i	DN(i)		Concentration of dissolved nitrogen at Station No. i, mg/l nitrogen.
$DNBC_i$	DNBC(i)		Concentration of dissolved non-biodegradable carbon at Station No. i, mg/l carbon.
DO	DO	1.0	Concentration of dissolved oxygen in aerator, mg/l oxygen.
DOC_i	DOC(i)		Concentration of all dissolved organic carbon at Station No. i, mg/l carbon.
DOSAT	DOSAT		Saturation value for dissolved oxygen in the aerator at one-half the water depth, mg/l oxygen.
DP_i	DP(i)		Concentration of dissolved phosphorus at Station No. i, mg/l phosphorus.
	EFF		Efficiency of aerator, pounds of carbon which escape to the atmosphere per day as carbon dioxide divided by pounds of carbon entering aerator per day.
ERR	ERR	0.76	Solids recovery ratio for elutriation, total solids in stream 15 divided by total solids in stream 13, (lb/day)/(lb/day).
	ERROR		Difference between FMAX and FMIN.
FECL3	$FECL_3$		Concentration of ferric chloride used for sludge conditioning, mg/l $FeCl_3$.
$FOOD_{max}$	FMAX		Current maximum value for FOOD, mg/l 5-day BOD[b].
$FOOD_{min}$	FMIN		Current minimum value for FOOD, mg/l 5-day BOD.

[a] mg/l = milligrams per liter.

[b] BOD = Biochemical Oxygen Demand.

Table A-1 VARIABLES AND PARAMETERS USED IN COST-PERFORMANCE COMPUTATION (Cont.)

Text Symbols	Computer Symbols	Nominal Value	Definitions and Comments
FOOD	FOOD		5-day BOD[a] synthesized to active solids in the aerator each day, mg/l[b] oxygen.
FRDIG	FRDIG		Fraction of carbon entering the digester which is converted to gas and removed from the sludge stream.
FRPS	FRPS	0.5	Fraction of solids entering the primary settler which is removed from the main stream and sent to the thickener via stream 8.
GE	GE	800.0	Design overflow rate for elutriation, gpd[c]/ sq. ft.
GES	GES	9.0	Design solids loading rate for elutriation, lb/day/sq. ft.
GPS	GPS		Computed overflow rate for primary settler, gpd/sq. ft.
GSS	GSS	2000.0	Design overflow rate for final settler, gpd/ sq. ft.
GSTH	GSTH	9.0	Design solids loading rate for thickener, lb/day/sq. ft.
GTH	GTH	750.0	Design overflow rate for thickener, gpd/sq. ft.
	LOOPS		Number of iterative recycle calculations when Stream No. 9 is returned.
	NAS		Number of input values for MLSS.
	NBOD		Number of input values for BOD_5.
	NFORK(i)		An input parameter used in the program to include or exclude various processes.

[a] BOD = Biochemical Oxygen Demand.

[b] mg/l = Milligrams per liter.

[c] gpd = Gallons per day.

Table A-1 VARIABLES AND PARAMETERS USED IN COST-PERFORMANCE COMPUTATION (Cont.)

Text Symbols	Computer Symbols	Nominal Value	Definitions and Comments
	NFORK(j)		An input parameter which takes a value of 0 or 1 and is used in the program to include or exclude various processes.
Q_i	Q(i)		Volume flow at Station No. i, mgd[a].
	REMN		Fraction of nitrogen removed from the main stream by the aerator.
	REMP		Fraction of phosphorus removed from the main stream by the aerator.
p	RETURN		Sludge return ratio, Q_6/Q_2.
$SBOD_i$	SBOD(i)		Solid 5-day BOD[b], mg/l[c] oxygen at Station No. i.
	SBOD(4)		Solid unmetabolized 5-day BOD in aerator, mg/l oxygen.
SFM_i	SFM(i)		Concentration of solid inorganic matter at Station No. i, mg/l mass.
$SNBC_i$	SNBC(i)		Concentration of solid non-biodegradable carbon at Station No. i, mg/l carbon.
SOC_i	SOC(i)		Concentration of all solid carbon at Station No. i, mg/l carbon.
SON_i	SON(i)		Concentration of solid nitrogen at Station No. i, mg/l nitrogen.
SOP_i	SOP(i)		Concentration of solid phosphorus at Station No. i, mg/l phosphorus.
	TA		Aerator detention time, VAER/Q_2, days.
t	TAN		Aerator detention time required to achieve nitrification, days.

[a] mgd = Million gallons per day.

[b] BOD = Biochemical Oxygen Demand.

[c] mg/l = Milligrams per liter.

Table A-1 VARIABLES AND PARAMETERS USED IN COST-PERFORMANCE COMPUTATION (Cont.)

Text Symbols	Computer Symbols	Nominal Value	Definitions and Comments
	TBOD2		Total concentration of 5-day BOD[a] at Station 2, mg/l[b] oxygen.
	TBOD5		Total concentration of 5-day BOD at Station 5, mg/l oxygen.
TD	TD	15.0	Digester detention time, days.
T	TDIG	33.0	Sludge temperature in digester, degrees Centigrade.
	TEMPI		The Ith temporary storage space.
	TOC2		Concentration of all carbon at Station 2, mg/l carbon.
	TOC5		Concentration of all carbon at Station 5, mg/l carbon.
	TOC7		Concentration of all carbon at Station 7, mg/l carbon.
	TOL		Tolerance used in iterative loop.
	TOTAOC		Total amortization and operating cost for all processes, dollars/year.
	TOTCC		Total capital cost for all processes, dollars.
TRR	TRR	0.95	Solids recovery ratio for thickening, total solids in stream 12 divided by total solids in stream 10, (lb/day)/(lb/day).
TSS_i	TSS(i)		Total suspended solids at Station No. i, mg/l mass.
TVF	TVF	0.238	Fraction of the time vacuum filters are operated.
URPS	URPS	400.0	Ratio of solids concentration in stream 8 to solids concentration in stream 1, TSS_8/TSS_1.

[a] BOD = Biochemical Oxygen Demand.

[b] mg/l = Milligrams per liter.

Table A-1 VARIABLES AND PARAMETERS USED IN COST-PERFORMANCE COMPUTATION (Cont.)

Text Symbols	Computer Symbols	Nominal Value	Definitions and Comments
URSS	URSS	3.0	Ratio of solids concentration in underflow stream from final settler to the total solids concentration in the aerator, TSS_7/MLSS.
VAER	VAER		Volume of aerator, millions of gallons.
VDIG	VDIG		Volume of digester, cubic feet/1000.
VFL	VFL	4.9	Vacuum filter loading, gal/hr/sq. ft.
VNIT	VNIT		Volume of aerator required to achieve nitrification, millions of gallons.
VSS_i	VSS(i)		Concentration of volatile suspended solids at Station No. i, mg/l[a] mass.
	WAS		Pounds of active solids in the aerator, lb mass.
	WDN		Pounds per day of dissolved nitrogen in streams 5 and 7 from the aerator, lb/day nitrogen.
	WFOOD		Pounds per day of 5-day BOD[b] synthesized to active solids in the aerator, lb/day oxygen.
	WP		Percentage of moisture in filtered sludge.
	WRE	3.0	Wash water ratio for elutriation, Q_{17}/Q_{13}.
MLNBSS	XLNBSS		Concentration of inert organic solids in aerator caused by inert organic solids in influent, mg/l mass.
MLASS	XMLASS		Concentration of active solids held in aerator, mg/l mass.
MLBSS	XMLBSS		Concentration of unmetabolized biodegradable solids held in the aerator, mg/l mass.

[a] mg/l = Milligrams per liter.

[b] BOD = Biochemical Oxygen Demand.

Table A-1 VARIABLES AND PARAMETERS USED IN COST-PERFORMANCE COMPUTATION (Cont.)

Text Symbols	Computer Symbols	Nominal Value	Definitions and Comments
MLDSS	XMLDSS		Concentration of non-biodegradable solids in the aerator caused by destruction of active solids by natural causes, mg/l[a] mass.
MLISS	XMLISS		Concentration of inert inorganic solids in aerator, caused by inorganic solids in influent, mg/l mass.
MLSS	XMLSS		Total concentration of solids in aerator, mg/l mass.
	XRSS		Ratio of solids in the overflow stream from the aerator to the total solids held, TSS_5/MLSS.
	Y1		Alkalinity of sludge expressed as a percentage of the total solids.
	Y2		Ratio of volatile matter to ash for sludge.
	YTONS		Number of tons of sludge incinerated.
	ECF(I)		Excess Capacity Factor for the Ith Process. ECF is the ratio of capacity provided to that required by design relationships at the design point.
CTRP		0.10	Contractor's profit expressed as a fraction of the total capital cost.
CLAND		0.02	Cost of land expressed as a fraction of the total capital cost.
CTGO		0.15	Cost of contingencies and omissions expressed as a fraction of the total capital cost.
CENG			Cost of engineering services expressed as a fraction of the total capital cost.
CCR			Capital Cost Ratio CCR = 1 + CENG + CTRP + CLAND + CTGO

Table A-1 VARIABLES AND PARAMETERS USED IN COST-PERFORMANCE COMPUTATION (Cont.)

Text Symbols	Computer Symbols	Nominal Value	Definitions and Comments
	TACOST		Total Amortization Cost for the Plant expressed as dollars/yr.
	TCOSTO		Total Operating and Maintenance Cost for the Plant expressed in dollars/yr.
	CAPKG		Amortization Cost, cents/1000 gallons for entire plant.
	COPKG		Operating and Maintenance Cost, cents/1000 gallons for entire plant.
	TCOST		Sum of CAPKG and COPKG.

[a] mg/l = Milligrams per liter.

FORTRAN IV LISTING

```
      DOUBLE PRECISION PRO
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PROCSS
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,CS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CEDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKWH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GES(50),
     8AF(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG,ECF1,ECF2,ECF3,ECF4,AIRCFD
      DIMENSION IFLUN(10),LOOP(10)
C     INITIALIZE ALL ARRAYS TO ZERO
      DO 1 I=1,50
      PRO(I)=0.0
      FRPS(I)=0.0
      URPS(I)=0.0
      GPS(I)=0.0
      APS(I)=0.0
      BOD2(I)=0.0
      BOD5(I)=0.0
      CAER20(I)=0.0
      DO(I)=0.0
      DOSAT(I)=0.0
      AEFF20(I)=0.0
      URSS(I)=0.0
      XRSS(I)=0.0
      GSS(I)=0.0
      CAER(I)=0.0
      CEDR(I)=0.0
      VAER(I)=0.0
      VNIT(I)=0.0
      MLSS(I)=0
      MLASS(I)=0
      MLBSS(I)=0
      MLNBSS(I)=0
      MLDSS(I)=0
      MLISS(I)=0
      AFS(I)=0.0
      FOOD(I)=0.0
      RTURN(I)=0.
      CNIT(I)=0.0
      CKWH(I)=0.0
      CAIRP(I)=0.0
      BSIZE(I)=0.0
      TD(I)=0.0
      TDIG(I)=0.0
      C1DIG(I)=0.0
      C2DIG(I)=0.0
```

```
      VDIG(I)=0.0
      CH4CFD(I)=0.0
      CO2CFD(I)=0.0
      VFL(I)=0.0
      TVF(I)=0.0
      CFECL3(I)=0.0
      FECL3(I)=0.0
      HP(I)=0.0
      AVF(I)=0.0
      CCHEM(I)=0.0
      TRR(I)=0.0
      GTH(I)=0.0
      GSTH(I)=0.0
      ATHM(I)=0.0
      ERR(I)=0.0
      VRE(I)=0.0
      GE(I)=0.0
      GES(I)=0.0
      AE(I)=0.0
      SBL(I)=0.0
    1 ASB(I)=0.0
      DO 2 I=1,20
      DO 2 J=1,5
      COSTO(I,J)=0.
      ACOST(I,J)=0.
      TCOST(I,J)=0.
    2 CCOST(I,J)=0.
      DO 5 I=1,20
      DO 5 J=1,50
      TSMATX(I,J)=0.
    5 SMATX(I,J)=0.
      DO 10 I=1,16
      DO 10 J=1,20
   10 DMATX(I,J)=0.
      DO 15 I=1,10
      IFLUN(I)=0
      LOOP(I)=0
   15 NN(I)=0
  231 FORMAT (10A8)
C     COMPAR(1) = PREL,COMPAR(2) = PRSET,COMPAR(3) = AERFS,
C     COMPAR(4) = MIX,COMPAR(5) = SPLIT,COMPAR(6) = DIG,COMPAR(7) = VACF
C     COMPAR(8) = THICK,COMPAR(9) = ELUT,COMPAR(10) = SBEDS
      READ(60,231) (COMPAR(I),I=1,10)
C     READ NO. OF INPUT STREAMS, STREAM NOS., EPSILON
      READ(60,100) NIS,(NN(I),I=1,10),EPS
  100 FORMAT(11I4,5X,F10.3)
      J=0
      DO 20 I=1,NIS
      J=J+1
      NNN=NN(J)
      SMATX(1,NNN)=NNN
C     READ IN INPUT AND GUESS STREAMS
   20 READ(60,200) (SMATX(II,NNN),II=2,17)
  200 FORMAT(8F10.3/8F10.3)
C     READ THE COST CONSTANTS INTO THE DECISION MATRIX
      READ(60,400) (DMATX(I,20),I=1,16)
      PRINT 499
```

```
  499 FORMAT(1H1)
      PRINT 501
  501 FORMAT(1H1,////,T44,'INPUT  DATA',//,T19,5X,'K',5X,'N',3X,
     1'PROCESS',8X,'IS1',7X,'IS2',7X,'OS1',7X,'OS2',7X,'III',//)
C     READ THE PROCESS MATRIX FROM INPUT CARDS
   40 READ(60,300) K,N,PROCSS,IS1,IS2,OS1,OS2,III
  300 FORMAT(I1,1X,I2,2X,A8,5X,I2,8X,I2,8X,I2,8X,I2,28X,I1)
      PRINT 502,K,N,PROCSS,IS1,IS2,OS1,OS2,III
  502 FORMAT(23X,I1,5X,I1,4X,A8,9X,I2,8X,I2,8X,I2,8X,I2,8X,I1)
      IF ( K.EQ. 9) GO TO 47
   43 SMATX(1,IS1)=IS1
      SMATX(1,OS1)=OS1
      IF(IS2.EQ.0) GO TO 230
      SMATX(1,IS2)=IS2
  230 IF(OS2.EQ.0) GO TO 240
      SMATX(1,OS2)=OS2
  240 IF(N.EQ.0) GO TO 47
      PRO(N)=PROCSS
C     READ INPUT VALUES FROM THE DECISION MATRIX (IF N.NE.0)
   45 READ(60,400) (DMATX(I,N),I=1,16)
  400 FORMAT(8F10.3/8F10.3)
C     WRITE THE PROCESS MATRIX ON LU10
   47 WRITE(10,300) K,N,PROCSS,IS1,IS2,OS1,OS2,III
      IF ( K .EQ. 9) GO TO 48
      GO TO 40
   48 ENDFILE 10
      REWIND 10
      K=0
      INDC=0
      IN=1
   58 IFLUNK=0
   55 IFLUN(IN)=0
      KOUT=0
   53 READ(10,300) K,N,PROCSS,IS1,IS2,OS1,OS2,III
      IF (K .EQ. 9) GO TO 220
   59 IF(K.NE.0.AND.INDC.EQ.0) INDC=K
      IF(K.EQ.INDC.OR.K.EQ.0) GO TO 77
      LOOP(IN)=INDC
      IN=IN+1
      INDC=K
      KOUT=0
      IF(IFLUNK.EQ.1) GO TO 77
      IFLUNK=IFLUN(IN-1)
   77 IF(K.EQ.INDC) KOUT=KOUT+1
      IF(PROCSS.EQ.COMPAR(1)) GO TO 401
  425 IF(PROCSS.EQ.COMPAR(2)) GO TO 402
  426 IF(PROCSS.EQ.COMPAR(3)) GO TO 403
  427 IF(PROCSS.EQ.COMPAR(4)) GO TO 404
  428 IF(PROCSS.EQ.COMPAR(5)) GO TO 405
  429 IF(PROCSS.EQ.COMPAR(6)) GO TO 406
  430 IF(PROCSS.EQ.COMPAR(7)) GO TO 407
  431 IF(PROCSS.EQ.COMPAR(8)) GO TO 408
  432 IF (PROCSS.EQ.COMPAR(9)) GO TO 409
  433 IF (PROCSS.EQ.COMPAR(10)) GO TO 410
      GO TO 1000
```

```
  401 CALL PREL
      GO TO 425
  402  CALL PRSET
      GO TO 426
  403  CALL AERFS
      GO TO 427
  404  CALL MIX
       GO TO 428
  405 CALL SPLIT
      GO TO 429
  406 CALL DIG
      GO TO 430
  407 CALL VACF
      GO TO 431
  408 CALL THICK
      GO TO 432
  409  CALL ELUT
      GO TO 433
  410 CALL SBEDS
 1000 IF(III.EQ.2) GO TO 55
C     TEST THE CALCULATED STREAM VALUES WITH TOLERANCE EPSILON
      DO 60 I=2,17
      IF (ABS(SMATX(I,OS1)-TSMATX(I,OS1)) .GT. EPS) GO TO 70
   60 CONTINUE
      IF(OS2.EQ.0) GO TO 80
      DO 65 I=2,17
      IF (ABS(SMATX(I,OS2)-TSMATX(I,OS2)) .GT. EPS) GO TO 70
   65 CONTINUE
      GO TO 80
   70 IFLUN(IN)=1
C     STORE THE CALCULATED STREAM VALUES IN THE TEMPORARY MATRIX
   80 DO 90 I=1,20
   90 TSMATX(I,OS1)=SMATX(I,OS1)
      IF(OS2.EQ.0) GO TO 120
      DO 110 I=1,20
  110 TSMATX(I,OS2)=SMATX(I,OS2)
  120 IF(KOUT.NE.2) GO TO 53
      IF(IFLUN(IN).EQ.0.AND.IFLUNK.EQ.0.AND.III.EQ.1) GO TO 160
      IF(IFLUN(IN).EQ.0) GO TO 121
      REWIND 10
  150 READ(10,300) K,N,PROCSS,IS1,IS2,OS1,OS2,III
      IF(K.NE.INDC) GO TO 150
      BACKSPACE 10
      IF(III.EQ.1) GO TO 58
      GO TO 55
  121 INDC=LOOP(IN-1)
      KOUT=1
      IN=IN-1
      GO TO 53
  160 INDC=0
      GO TO 58
C     CALL THE SUBROUTINES THAT CALCULATE COSTS AND PRINT THE OUTPUT
  220 CALL COST
      CALL PRINT
      STOP
      END
```

```
      SUBROUTINE PRSET
      DOUBLE PRECISION PROCSS
      DOUBLE PRECISION PRO
      DOUBLE PRECISION COMPAR
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CEDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKWH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG
      FRPS(N)=DMATX(1,N)
      URPS(N)=DMATX(2,N)
      ECF(N)=DMATX(16,N)
      SMATX(2,OS2)=FRPS(N)*SMATX(2,IS1)/URPS(N)
      SMATX(2,OS1)=SMATX(2,IS1)-SMATX(2,OS2)
      TEMP1=(1.-FRPS(N))*SMATX(2,IS1)/SMATX(2,OS1)
      DO 10 I=3,10
   10 SMATX(I,OS1)=TEMP1*SMATX(I,IS1)
      DO 20 I=11,17
      SMATX(I,OS2)=SMATX(I,IS1)
   20 SMATX(I,OS1)=SMATX(I,OS2)
      TEMP1=FRPS(N)*SMATX(2,IS1)/SMATX(2,OS2)
      DO 30 I=3,10
   30 SMATX(I,OS2)=TEMP1*SMATX(I,IS1)
      GPS(N)=-2780.*ALOG(FRPS(N))-551.7
      APS(N)=SMATX(2,IS1)*1000./GPS(N)
      APS(N)=APS(N)*ECF(N)
      CCOST(N,1)=13.4*APS(N)+5.2*APS(N)**.10
      COSTO(N,1)=1.0*APS(N)+2.5*APS(N)**.5
  100 FORMAT(5X,5HPRSET)
      PRINT 100
      RETURN
      END
```

```
      SUBROUTINE AERFS
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PRO
      DOUBLE PRECISION PROCSS
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CFDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKNH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG,ECF1,ECF2,ECF3,ECF4,AIRCFD
      BOD2(N)=SMATX(8,IS1)+SMATX(17,IS1)
      DBOD2=SMATX(17,IS1)
      ECF1=DMATX(16,N)
      ECF2=DMATX(15,N)
      ECF3=DMATX(14,N)
      ECF4=DMATX(13,N)
      BOD5(N)=DMATX(1,N)
      XMLSS=DMATX(2,N)
      DEGC=DMATX(3,N)
      CAER20(N)=DMATX(4,N)
      DO(N)=DMATX(5,N)
      AEFF20(N)=DMATX(6,N)
      URSS(N)=DMATX(7,N)
      GSS(N)=DMATX(8,N)
       CFDR(N)=.18*1.047**(DEGC-28.)
      CAER(N)=CAER20(N)*1.047**(DEGC-20.)
      SA=XMLSS/1000.
      TA=(BOD2(N)-BOD5(N))/(BOD5(N)*CAER(N)*SA*24.)
      VAER(N)=SMATX(2,IS1)*TA
      XRSS(N)=556.1*GSS(N)**.4942/XMLSS**1.8165/(TA*24.)**.4386
      ASMAX=BOD5(N)/XRSS(N)/.685
      ASMIN=0.0
      IF(ASMAX-XMLSS)50,50,70
   70 ASMAX=XMLSS
   50 XMLASS=(ASMAX+ASMIN)/2.0
   42 FOOD(N)=SMATX(8,IS1)+DBOD2
      FMAX=FOOD(N)
      N1=1
      GO TO 8
    7 ERROR=FMAX-FMIN
      TOL=.10
      IF(ERROR-TOL)21,21,19
   19 FOOD(N)=(FMAX+FMIN)/2.0
    4 IF (FOOD(N)-SMATX(17,IS1)) 5,5,6
    5 DBOD4=SMATX(17,IS1)-FOOD(N)
      SBOD4=SMATX(8,IS1)
```

```
      GO TO 8
    6 SBOD4=(SMATX(8,IS1)+SMATX(17,IS1)-FOOD(N))*.70
      DBOD4=.233*SBOD4
    8 TEMP1=(.65*FOOD(N)/XMLASS)-XRSS(N)
      SMATX(2,OS2)=(SMATX(2,IS1)*TEMP1-CEDR(N)*VAER(N))/(URSS(N)
     2-XRSS(N))
   20 SMATX(2,OS1)=SMATX(2,IS1)-SMATX(2,OS2)
      N1=N1+1
      IF(N1-2)23,23,22
   22 TEMP2=XRSS(N)*SMATX(2,OS1)+URSS(N)*SMATX(2,OS2)
      XMLBSS=SMATX(2,IS1)*SBOD4/TEMP2/.80
      SMATX(8,OS1)=(XMLASS*.685+XMLBSS*.80)*XRSS(N)
      SMATX(17,OS1)=DBOD4
      TBOD5=SMATX(8,OS1)+SMATX(17,OS1)
      GO TO 24
   23 TBOD5=XMLASS*XRSS(N)*.685
   24 IF(TBOD5-BOD5(N)) 10,10,15
   10 IF(N1-3)11,12,13
   11 FMIN=(CEDR(N)*VAER(N)/SMATX(2,IS1)+XRSS(N))*XMLASS/.65
      FOOD(N)=FMIN
      GO TO 4
   12 PRINT 307
  307 FORMAT(6X,27HDEMAND MLASS CANNOT BE HELD)
      GO TO 25
   13 FMAX=FOOD(N)
      GO TO 7
   15 IF(N1-3)16,18,17
   16 PRINT 306
  306 FORMAT(6X,30HBOD5 DEMAND CANNOT BE ACHIEVED)
      GO TO 25
   17 FMIN=FOOD(N)
   18 GO TO 7
   21 CONTINUE
      XLNBSS=SMATX(4,IS1)*SMATX(2,IS1)*2.13/TEMP2
      XMLISS=SMATX(2,IS1)*SMATX(7,IS1)/TEMP2
      XMLDSS=(.12*SMATX(2,IS1)*FOOD(N)/TEMP2)-.185*XMLASS
      MLASS(N)=XMLASS
      MLBSS(N)=XMLBSS
      MLNBSS(N)=XLNBSS
      MLDSS(N)=XMLDSS
      MLISS(N)=XMLISS
      MLSS(N)=XMLSS
      TEMP1=XMLASS+XMLBSS+XLNBSS+XMLDSS+XMLISS
      TEMP2=TEMP1-XMLSS
      TOL=5.
      IF (ABS(TEMP2)-TOL) 41,41,51
   51 IF(TEMP2)52,52,53
   52 ASMIN=XMLASS
      GO TO 50
   53 ASMAX=XMLASS
      GO TO 50
   41 CONTINUE
       SMATX(3,CS1)=(XMLDSS+XMLASS)*XRSS(N)/2.46+(XMLBSS+XLNBSS)*
     1XRSS(N)/2.33
```

```
      SMATX(4,OS1)=XLNBSS*XRSS(N)/2.33+(XMLOSS+.185*XMLASS)*XRSS(N)/2.46
      TEMP2=XRSS(N)*XMLASS/2.46
      SMATX(5,OS1)=.234*TEMP2+(SMATX(3,OS1)-TEMP2)/10.
      SMATX(6,OS1)=SMATX(3,OS1)*.01
      SMATX(7,OS1)=XMLISS*XRSS(N)
      SMATX(9,OS1)=SMATX(3,OS1)*2.38
      SMATX(10,OS1)=SMATX(7,OS1)+SMATX(9,OS1)
      DO 71 I=3,10
   71 SMATX(I,OS2)=SMATX(I,OS1)*URSS(N)/XRSS(N)
      SMATX(11,OS1)=SMATX(12,IS1)+DBOD4/1.87
      SMATX(12,OS1)=SMATX(12,IS1)
      SMATX(13,OS1)=(SMATX(2,IS1)*(SMATX(5,IS1)+SMATX(13,IS1))
     1-(SMATX(5,OS1)*SMATX(2,OS1)+SMATX(5,OS2)*SMATX(2,OS2)))
     2/(SMATX(2,OS1)+SMATX(2,OS2))
      SMATX(14,OS1)=(SMATX(2,IS1)*(SMATX(6,IS1)+SMATX(14,IS1))
     1-(SMATX(6,OS1)*SMATX(2,OS1)+SMATX(6,OS2)*SMATX(2,OS2)))
     2/(SMATX(2,OS1)+SMATX(2,OS2))
      SMATX(15,OS1)=SMATX(15,IS1)
      DO 72 I=11,15
   72 SMATX(I,OS2)=SMATX(I,OS1)
      Q6=(SMATX(2,IS1)*(1.-.65*FOOD(N)/XMLASS)+CEDR(N)*VAER(N))
     1/(URSS(N)-1.)
      RTURN(N)=Q6/SMATX(2,IS1)
      X4X3=(1.+RTURN(N))/RTURN(N)/URSS(N)
      DN3=SMATX(13,IS1)/(1.+RTURN(N))
      X3Y=DN3*.99/(X4X3-1.)
      CNIT(N)=.18*EXP(.116*(DEGC-15.))
      IF (X4X3) 101,101,102
  101 PRINT 104
  104 FORMAT(10X,'X4X3 LESS THAN OR = 0.0')
      TTAN=0.0
      GO TO 103
  102 TTAN=(1.+RTURN(N))*(ALOG(X4X3)+4.605/(DN3+X3Y))/CNIT(N)
      PRINT 105
  105 FORMAT(10X,'X4X3 IS POSITIVE')
  103 VNIT(N)=SMATX(2,IS1)*TTAN
      IF(VNIT(N)-VAER(N)) 60,60,61
   60 SMATX(16,OS1)=SMATX(16,IS1)+3.57*(SMATX(13,OS1)-SMATX(13,IS1))
      GO TO 62
   61 SMATX(16,OS1)=SMATX(16,IS1)
   62 SMATX(16,OS2)=SMATX(16,OS1)
      SMATX(17,OS2)=SMATX(17,OS1)
      DOSAT(N)=14.16-.3943*DEGC+.007714*DEGC**2
     1-.0000646*DEGC**3
      DOSAT(N)=DOSAT(N)*1.221
      AEFF=AEFF20(N)*(DOSAT(N)-DO(N))*1.02**(DEGC-20.)/DOSAT(N)
      WFOOD=SMATX(2,IS1)*FOOD(N)*8.33
      WAS=XMLASS*VAER(N)*8.33
      AIRCFD=(.577*WFOOD+1.16*CEDR(N)*WAS)/AEFF/.232/.075
      WDN=(SMATX(2,OS1)*SMATX(13,OS1)+SMATX(2,OS2)*SMATX(13,OS2))*8.33
      IF (VNIT(N)-VAER(N)) 26,26,27
```

```
 26 AIRCFD=AIRCFD+4.6*WDN/AEFF/.232/.075
 27 BSIZE(N)=ECF2*AIRCFD/1440.
    CFPGAL(N)=AIRCFD/1000000./SMATX(2,IS1)
    VAER(N)=VAER(N)*ECF1
    Q4=Q6+SMATX(2,IS1)
    Q6=Q6*ECF3
    AFS(N)=Q4*1000./GSS(N)
    AFS(N)=AFS(N)*ECF4
    CKWH(N)=DMATX(1,20)
    CAIRP(N)=AIRCFD*365.*CKWH(N)/1830000.
    CCOST(N,1)=175.*VAER(N)+36.5*VAER(N)**.182
    CCOST(N,2)=10.57+.005857*BSIZE(N)
    CCOST(N,3)=3.65+1.125*Q6
    CCOST(N,4)=12.6*AFS(N)+5.35/AFS(N)**.126
    COSTO(N,1)=10.*VAER(N)+14.5*VAER(N)**.50
    COSTO(N,2)=CAIRP(N)
    COSTO(N,3)=0.0
    COSTO(N,4)=0.0
100 FORMAT(5X,5HAERFS)
    PRINT 100
 25 RETURN
    END
```

```
      SUBROUTINE MIX
      DOUBLE PRECISION PRO
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PROCSS
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CEDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKWH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCP,
     XTCOSTO,CEMG
      SMATX(2,OS1)=SMATX(2,IS1)+SMATX(2,IS2)
      IF (SMATX(2,OS1) .EQ. 0.0) GO TO 101
      TEMP1=SMATX(2,IS1)/(SMATX(2,IS1)+SMATX(2,IS2))
      TEMP2=SMATX(2,IS2)/(SMATX(2,IS1)+SMATX(2,IS2))
      DO 10 I=3,17
   10 SMATX(I,OS1)=TEMP1*SMATX(I,IS1)+TEMP2*SMATX(I,IS2)
  100 FORMAT(5X,3HMIX)
  101 CONTINUE
      PRINT 100
      RETURN
      END
```

```
      SUBROUTINE SPLIT
      DOUBLE PRECISION PRO
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PROCSS
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CEDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKWH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG
      SMATX(2,OS1)=SMATX(2,IS1)-SMATX(2,OS2)
      DO 10 I=3,17
      SMATX(I,OS1)=SMATX(I,IS1)
   10 SMATX(I,OS2)=SMATX(I,IS1)
  100 FORMAT(5X,5HSPLIT)
      PRINT 100
      RETURN
      END
```

```
      SUBROUTINE DIG
      DOUBLE PRECISION PRO
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PROCSS
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CFDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKMH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRF(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG
      C1DIG(N)=.28/EXP(.036*(35.-TDIG(N)))
      TD(N)=DMATX(1,N)
      TDIG(N)=DMATX(2,N)
      C2DIG(N)=700.*EXP(.10*(35.-TDIG(N)))
      IF (TD(N)-10.) 10,10,20
   10 TD(N)=10.
   20 DIGC13=C2DIG(N)/(C1DIG(N)*TD(N)-1.)
      DIGC12=SMATX(3,IS1)-SMATX(4,IS1)+SMATX(11,IS1)
     1-SMATX(12,IS1)
      TEMP4=(DIGC12-DIGC13)/(SMATX(3,IS1)+SMATX(11,IS1))
      SMATX(2,OS1)=SMATX(2,IS1)
      SMATX(3,OS1)=SMATX(4,IS1)+.75*DIGC13
      SMATX(4,OS1)=SMATX(4,IS1)
      SMATX(5,OS1)=(1.-TEMP4)*SMATX(5,IS1)
      SMATX(6,OS1)=(1.-TEMP4)*SMATX(6,IS1)
      SMATX(7,OS1)=SMATX(7,IS1)
      SMATX(8,OS1)=(SMATX(3,OS1)-SMATX(4,OS1))*1.87
      SMATX(9,OS1)=SMATX(3,OS1)*2.38
      SMATX(10,OS1)=SMATX(9,OS1)+SMATX(7,OS1)
      SMATX(11,OS1)=SMATX(12,IS1)+.25*DIGC13
      SMATX(12,OS1)=SMATX(12,IS1)
      SMATX(13,OS1)=SMATX(13,IS1)+SMATX(5,IS1)*.65*TEMP4
      SMATX(14,OS1)=SMATX(14,IS1)+TEMP4*SMATX(6,IS1)
      SMATX(15,OS1)=SMATX(15,IS1)
      SMATX(16,OS1)=SMATX(16,IS1) +(SMATX(13,OS1)-SMATX(13,IS1))*3.57
      SMATX(17,OS1)=(SMATX(11,OS1)-SMATX(12,OS1))*1.87
      VDIG(N)=SMATX(2,IS1)*TD(N)*1000./7.48
      CH4CFD(N)=163.85*(DIGC12-DIGC13)*SMATX(2,IS1)
      CO2CFD(N)=249.9*(DIGC12-DIGC13)*SMATX(2,IS1)-CH4CFD(N)
      ECF(N)=DMATX(16,N)
      VDIG(N)=VDIG(N)*ECF(N)
      CCOST(N,1)=1.04*VDIG(N)+10.7*VDIG(N)**.128
      CCOST(N,2)=.005+.040*VDIG(N)
      COSTO(N,1)=.048*VDIG(N)+.54*VDIG(N)**.44
  100 FORMAT(5X,3HDIG)
      PRINT 100
      RETURN
      END
```

```
      SUBROUTINE VACF
      DOUBLE PRECISION PROCSS
      DOUBLE PRECISION PRO
      DOUBLE PRECISION COMPAR
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CEDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKWH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG
      TVF(N)=DMATX(2,N)
      VFL(N)=DMATX(1,N)
      AVF(N)=SMATX(2,OS2)*1000000./VFL(N)/TVF(N)/24.
      SMATX(10,OS2)=DMATX(3,N)
      ECF(N)=DMATX(16,N)
      Y1=100.*SMATX(16,IS1)/SMATX(10,IS1)
      Y2=SMATX(9,IS1)/(SMATX(10,IS1)+SMATX(9,IS1))
      CFECL3(N)=DMATX(7,20)
      FECL3(N)=1.08*Y1+2.*Y2
      WP(N)=88./(SMATX(10,IS1)/10000.)**.123
      TEMP1=1000000.*(100.-WP(N))/WP(N)
      SMATX(2,OS2)=SMATX(2,IS1)*(TEMP1-SMATX(10,IS1))
     1/(TEMP1-SMATX(10,OS2))
      SMATX(10,OS1)=8.33*(SMATX(2,IS1)*SMATX(10,IS1)
     1-SMATX(2,OS2)*SMATX(10,OS2))
      TEMP1=SMATX(10,OS1)/SMATX(10,IS1)
      TEMP2=SMATX(10,OS2)/SMATX(10,IS1)
      DO 10 I=3,9
      SMATX(I,OS1)=TEMP1*SMATX(I,IS1)
   10 SMATX(I,OS2)=TEMP2*SMATX(I,IS1)
      TEMP3=SMATX(10,OS2)/SMATX(10,IS1)
      DO 20 I=11,17
      SMATX(I,OS2)=SMATX(I,IS1)
   20 SMATX(I,OS1)=TEMP1*SMATX(I,IS1)
      AVF(N)=AVF(N)*ECF(N)
      CCOST(N,1)=12.8+.372*AVF(N)
      CCHEM(N)=SMATX(10,IS1)*FECL3(N)*SMATX(2,IS1)*30.4*CFECL3(N)
      COSTO(N,1)=CCHEM(N)/1000.+1.5*SMATX(2,1)+6.45*SMATX(2,1)**.37
  100 FORMAT(5X,4HVACF)
      PRINT 100
      RETURN
      END
```

```
      SUBROUTINE THICK
      DOUBLE PRECISION PROCSS
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PRO
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),UPPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CEDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKWH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG
      TRR(N)=DMATX(1,N)
      SMATX(10,OS1)=DMATX(2,N)
      GTH(N)=DMATX(3,N)
      GSTH(N)=DMATX(4,N)
      SMATX(2,OS1)=TRR(N)*SMATX(2,IS1)*SMATX(10,IS1)/SMATX(10,OS1)
      SMATX(2,OS2)=SMATX(2,IS1)-SMATX(2,OS1)
      SMATX(10,OS2)=(1.-TRR(N))*SMATX(2,IS1)*SMATX(10,IS1)/SMATX(2,OS2)
      TEMP4=SMATX(10,OS2)/SMATX(10,IS1)
      DO 10 I=3,9
   10 SMATX(I,OS2)=TEMP4*SMATX(I,IS1)
      DO 20 I=11,17
      SMATX(I,OS1)=SMATX(I,IS1)
   20 SMATX(I,OS2)=SMATX(I,IS1)
      TEMP3=SMATX(10,OS1)/SMATX(10,IS1)
      DO 30 I=3,9
   30 SMATX(I,OS1)=TEMP3*SMATX(I,IS1)
      ATH1=SMATX(2,IS1)*1000000./GTH(N)
      ATH2=SMATX(2,IS1)*SMATX(10,IS1)*8.33/GSTH(N)
      ATHM(N)=AMAX1(ATH1,ATH2)
      ECF(N)=DMATX(16,N)
      ATHM(N)=ECF(N)*ATHM(N)
      CCOST(N,1)=(.0181+.00846/EXP (ATHM(N)/13375.))*ATHM(N)
      COSTO(N,1)=0.
  100 FORMAT(5X,5HTHICK)
      PRINT 100
      RETURN
      END
```

```
      SUBROUTINE ELUT
      DOUBLE PRECISION PROCSS
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PRO
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CEDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKWH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG
      ERR(N)=DMATX(1,N)
      SMATX(10,OS1)=DMATX(2,N)
      WRE(N)=DMATX(3,N)
      GE(N)=DMATX(4,N)
      GES(N)=DMATX(5,N)
      SMATX(2,IS2)=WRE(N)*SMATX(2,IS1)
      TEMP1=SMATX(2,IS1)*1000000./GE(N)
      TEMP2=SMATX(2,IS1)*SMATX(10,IS1)*8.33/GES(N)
      AE(N)=AMAX1(TEMP1,TEMP2)
      SMATX(2,OS1)=ERR(N)*SMATX(2,IS1)*SMATX(10,IS1)/SMATX(10,OS1)
      SMATX(2,OS2)=SMATX(2,IS1)+SMATX(2,IS2)-SMATX(2,OS1)
      SMATX(10,OS2)=SMATX(2,IS1)*((1.-ERR(N))*SMATX(10,IS1)
     1+WRE(N)*SMATX(10,IS2))/SMATX(2,OS2)
      TEMP1=SMATX(10,OS1)/SMATX(10,IS1)
      TEMP2=SMATX(10,OS2)/SMATX(10,IS1)
      DO 10 I=3,9
      SMATX(I,OS1)=TEMP1*SMATX(I,IS1)
   10 SMATX(I,OS2)=TEMP2*SMATX(I,IS2)
      TEMP1=SMATX(2,IS1)/(SMATX(2,IS1)+SMATX(2,IS2))
      TEMP2=SMATX(2,IS2)/(SMATX(2,IS1)+SMATX(2,IS2))
      DO 20 I=11,17
      SMATX(I,OS2)=TEMP1*SMATX(I,IS1)+TEMP2*SMATX(I,IS2)
   20 SMATX(I,OS1)=SMATX(I,OS2)
      ECF(N)=DMATX(16,N)
      AE(N)=AE(N)*ECF(N)
      CCOST(N,1)=(.0181+.0495/EXP (AE(N)/6000.))*AE(N)
      COSTO(N,1)=0.
  100 FORMAT(5X,4HELUT)
      PRINT 100
      RETURN
      END
```

```
      SUBROUTINE PREL
      DOUBLE PRECISION PROCSS
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PRO
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CEDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKNH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),MN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG
      DO 20 I=2,17
   20 SMATX(I,OS1)=SMATX(I,IS1)
      ECF(N)=DMATX(16,N)
      C1=SMATX(2,IS1)*ECF(N)
      CCOST(N,1)=14.7*C1**.625
      COSTO(N,1)=.5*C1+2.15*C1**.37
  100 FORMAT(5X,4HPREL)
      PRINT 100
      RETURN
      END
```

```
      SUBROUTINE SBEDS
      DOUBLE PRECISION PROCSS
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PRO
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CEDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKNH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50)
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GFS(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG
      SBL(N)=DMATX(1,N)
      ASB(N)=SMATX(10,IS1)*SMATX(2,IS1)*8.33*30./SBL(N)
      ECF(N)=DMATX(16,N)
      ASB(N)=ECF(N)*ASB(N)
      CCOST(N,1)=.0023*ASB(N)
      COSTO(N,1)=0.
  100 FORMAT(5X,5HSBEDS)
      PRINT 100
      RETURN
      END
```

```
      SUBROUTINE COST
      DOUBLE PRECISION PROCSS
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PRO
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),ERPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CFDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKWH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRF(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG
      AF=DMATX(3,20)
      CCI=DMATX(2,20)
      CTRP=DMATX(4,20)
      CTGO=DMATX(5,20)
      CLAND=DMATX(6,20)
      DO316J=1,20
      DO316K=1,5
  316 CCOST(J,K)=CCI*CCOST(J,K)
      TOTCC=0.
      DO310J=1,20
      DO310K=1,5
  310 TOTCC=TOTCC+CCOST(J,K)
      CENG=.08*(1000./TOTCC)**.146
      CCR=1.+CENG+CTRP+CTGO+CLAND
      TOTCC=TOTCC*CCR
      DO311J=1,20
      DO311K=1,5
  311 CCOST(J,K)=CCR*CCOST(J,K)
      DO312J=1,20
      DO312K=1,5
  312 ACOST(J,K)=AF*CCOST(J,K)/3.65/SMATX(2,1)
      TACOST=0.0
      DO 317 J=1,20
      DO 317 K=1,5
  317 TACOST=TACOST+ACOST(J,K)
      DO313J=1,20
      DO313K=1,5
  313 COSTO(J,K)=COSTO(J,K)/3.65/SMATX(2,1)
      TCOSTO=0.0
      DO 318 J=1,20
      DO 318 K=1,5
  318 TCOSTO=TCOSTO+COSTO(J,K)
      DO314J=1,20
      DO314K=1,5
  314 TCOST(J,K)=COSTO(J,K)+ACOST(J,K)
      TOTTC=0.
      DO315J=1,20
      DO315K=1,5
  315 TOTTC=TOTTC+TCOST(J,K)
  100 FORMAT(5X,4HCOST)
      PRINT 100
      RETURN
      END
```

```
      SUBROUTINE PRINT
      DOUBLE PRECISION COMPAR
      DOUBLE PRECISION PRO
      DOUBLE PRECISION PROCSS
      DOUBLE PRECISION IPRO (50)
      INTEGER OS1,OS2
      COMMON/MATRIX/SMATX(20,50),DMATX(16,20),IS1,IS2,OS1,OS2,N
      COMMON/COSTS/CCOST(20,5),COSTO(20,5),ACOST(20,5),TCOST(20,5)
      COMMON/MISC/PRO(50),COMPAR(20),FRPS(50),URPS(50),GPS(50),APS(50),
     1DEGC,CAER(50),CAER20(50),DO(50),DOSAT(50),AEFF20(50),URSS(50),
     2XRSS(50),GSS(50),CEDR(50),VAER(50),VNIT(50),MLSS(50),MLASS(50),
     3MLBSS(50),MLNBSS(50),MLDSS(50),AFS(50),FOOD(50),RTURN(50),
     4MLISS(50),CNIT(50),CKWH(50),CFPGAL(50),CAIRP(50),BSIZE(50),TD(50),
     5TDIG(50),C1DIG(50),C2DIG(50),VDIG(50),CH4CFD(50),CO2CFD(50),
     6VFL(50),TVF(50),CFECL3(50), FECL3(50),WP(50),AVF(50),CCHEM(50),
     7TRR(50),GTH(50),GSTH(50),ATHM(50),ERR(50),WRE(50),GE(50),GES(50),
     8AE(50),SBL(50),ASB(50),NN(10),TSMATX(20,50),ECF(50),
     9BOD2(50),BOD5(50),CCI,AF,CTRP,CTGO,CLAND,TOTCC,TOTTC,TACOST,CCR,
     XTCOSTO,CENG,ECF1,ECF2,ECF3,ECF4,AIRCFD
      DO 12 I=1,50
   12 IPRO(I)=PRO(I)
      PRINT 1007
 1007 FORMAT(1H1)
      PRINT 1005
      PRINT 1000
 1005 FORMAT(///T55,'STREAM  CHARACTERISTICS',/)
 1000 FORMAT(T79,'VOLUME FLOW, MILLIONS OF GALLONS PER DAY',/T79,
     1'CONCENTRATIONS, MILLIGRAMS/LITER')
      DO 10 I=1,50
      IF(SMATX(1,I).EQ.0) GO TO 10
      PRINT 100, SMATX(1,I)
      PRINT 200, (SMATX(J,I),J=2,9)
      PRINT 300
      PRINT 400,SMATX(16,I),(SMATX(J,I),J=11,15),SMATX(17,I),SMATX(10,I)
   10 CONTINUE
  100 FORMAT(2X,1HS,F3.0,12X,1HQ,9X,3HSOC,7X,4HSNBC,8X,3HSON,8X,3HSOP,
     1   8X,3HSFM,7X,4HSBOD,8X,3HVSS)
  200 FORMAT(13X,8F11.3)
  300 FORMAT(16X,3HALK,8X,3HDOC,7X,4HDNBC,9X,2HDN,9X,2HDP,8X,3HDFM,7X,
     1   4HDBOD,8X,3HTSS)
  400 FORMAT(13X,8F11.3//)
      PRINT 1007
      PRINT 1001
 1001 FORMAT(//T55,'PROCESS  CHARACTERISTICS',/)
      PRINT 1002
 1002 FORMAT(T79,'CCOST=CAPITAL COST,THOUSANDS OF DOLLARS',/T79,
     1'COSTO=OPERATING + MAINTENANCE COST, CENTS/1000 GAL.',/T79,
     2'ACOST=AMORTIZATION COST, CENTS/1000 GAL.',/T79,'TCOST=TOTAL TREAT
     3MENT COST, CENTS/1000 GAL.'//)
      DO 20 I=1,50
      IF(IPRO(I).EQ.0) GO TO 20
      IF(PRO(I).EQ.COMPAR(2)) GO TO 30
      IF(PRO(I).EQ.COMPAR(3)) GO TO 40
```

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      IF(PRO(I).EQ.COMPAR(6)) GO TO 50
      IF(PRO(I).EQ.COMPAR(7)) GO TO 60
      IF(PRO(I).EQ.COMPAR(8)) GO TO 70
      IF(PRO(I).EQ.COMPAR(9)) GO TO 80
      IF(PRO(I).EQ.COMPAR(1)) GO TO 90
      IF(PRO(I).EQ.COMPAR(10)) GO TO 110
   30 PRINT 500,I
  500 FORMAT(1X,1HP,I2,2X,'PRIMARY',7X,'FRPS',6X,'URPS',6X,'GPS'7X,
     1'APS',7X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF')
  510 FORMAT(6X,'SETTLER',11X,F5.3,2X,F5.0,5X,F6.1,6X,F6.3,2X,F7.2,3X,
     1F7.2,3X,F7.2,3X,F7.2,2X,F3.1,//)
      PRINT 510,FRPS(I),URPS(I),GPS(I),APS(I),CCOST(I,1),COSTO(I,1),
     1ACOST(I,1),TCOST(I,1),ECF(I)
      GO TO 20
   40 PRINT 600,I
  600 FORMAT(1X,1HP,I2,2X,'AERATOR',6X,'BOD2',6X,'BOD5',6X,'DEGC',6X,
     1'CAER20',4X,'DO',8X,'DOSAT',5X,'AEFF20',4X,'URSS',6X,'XRSS',6X,
     2'AFS')
      PRINT 610,BOD2(I),BOD5(I),DEGC,CAER20(I),DO(I),DOSAT(I),AEFF20(I),
     1URSS(I),XRSS(I),AFS(I)
  610 FORMAT(4X,'FINAL SETTLER',4X,F5.1,5X,F4.1,6X,F3.0,7X,F5.3,4X,F3.0,
     17X,F4.1,6X,F5.3,5X,F5.2,5X,F6.4,4X,F5.2)
      PRINT 620,GSS(I),CAER(I),CEDR(I),VAER(I),VNIT(I),MLSS(I),MLASS(I),
     2MLBSS(I),MLNBSS(I)
  620 FORMAT(T20,'GSS',7X,'CAER',6X,'CEDR',6X,'VAER',6X,'VNIT',6X,
     1'MLSS',6X,'MLASS',5X,'MLBSS',5X,'MLNBSS',/T21,F5.0,5X,F5.3,5X,
     2F5.3,5X,F5.3,4X,F5.3,5X,I5,5X,I5,5X,I5,5X,I5)
      PRINT 630,MLDSS(I),MLISS(I),FOOD(I),RTURN(I),CNIT(I),CKWH(I),
     2AIRCFD,BSIZE(I),CFPGAL(I)
  630 FORMAT(T20,'MLDSS',5X,'MLISS',5X,'FOOD',6X,'RTURN',5X,'CNIT',6X,
     1'CKWH',6X,'AIRCFD',5X,'BSIZE',4X,'CFPGAL',/T21,I5,5X,I5,5X,F5.1,
     26X,F5.3,4X,F5.3,5X,F5.3,4X,F10.0,2X,F6.0,3X,F4.2,//)
      PRINT 640,ECF1,CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),ECF2,
     1CCOST(I,2),COSTO(I,2),ACOST(I,2),TCOST(I,2)
  640 FORMAT(T33,'ECF',7X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',/T20,
     1'AERATOR',7X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,//T20,'BLOWER',
     28X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,/)
      PRINT 650,ECF3,CCOST(I,3),COSTO(I,3),ACOST(I,3),TCOST(I,3)
  650 FORMAT(T20,'SLUDGE ',9X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,/T20,
     1'PUMPS',/)
      PRINT 660,ECF4,CCOST(I,4),COSTO(I,4),ACOST(I,4),TCOST(I,4)
  660 FORMAT(T20,'FINAL',9X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,/T20,
     1'SETTLER',///)
      GO TO 20
   50 PRINT 700,I
  700 FORMAT(1X,1HP,I2,2X,'DIGESTER',6X,'TD',8X,'TDIG',6X,'C1DIG',5X,
     1'C2DIG',5X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF')
      PRINT 705,TD(I),TDIG(I),C1DIG(I),C2DIG(I),CCOST(I,1),COSTO(I,1),
     1ACOST(I,1),TCOST(I,1),ECF(I)
  705 FORMAT(23X,F4.1,8X,F4.1,5X,F5.3,2X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,
     13X,F7.2,2X,F3.1)
      PRINT 710,VDIG(I),CH4CFD(I),CO2CFD(I)
  710 FORMAT(20X,'VDIG',6X,'CH4CFD',4X,'CO2CFD',/21X,F6.1,4X,F7.0,3X,
     1F7.0//)
      GO TO 20
   60 PRINT 750,I,VFL(I),TVF(I),CFECL3(I),FECL3(I),CCOST(I,1),
```

```
     1COSTO(I,1),ACOST(I,1),TCOST(I,1),ECF(I),WP(I),AVF(I),CCHEM(I)
750  FORMAT(1X,1HP,I2,2X,'VACUUM',7X,'VFL',7X,'TVF',7X,'CFECL3',4X,
     1'FECL3',5X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF',/T7,
     2'FILTER',8X,F4.1,6X,F5.3,5X,F5.3,5X,F6.4,4X,F7.2,3X,F7.2,3X,F7.2,
     33X,F7.2,2X,F3.1,/T20,'WP',8X,'AVF',7X,'CCHEM',/T21,F4.1,6X,F6.1,
     44X,F7.0,//)
      GO TO 20
  70  PRINT 800,I,TRR(I),GTH(I),GSTH(I),ATHM(I),CCOST(I,1),COSTO(I,1),
     1ACOST(I,1),TCOST(I,1),ECF(I)
800  FORMAT(1X,1HP,I2,2X,'THICKNER',5X,'TRR',7X,'GTH',7X,'GSTH',6X,
     1'ATHM',6X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF',/T21,
     2F5.3,5X,F5.0,5X,F4.1,6X,F7.0,3X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,2X,
     3F3.1,//)
      GO TO 20
  80  PRINT 850,I
850  FORMAT(1X,1HP,I2,2X,'ELUTRIATE',5X,'ERR',7X,'WRE',7X,'GE',8X,
     1'GES',7X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF')
      PRINT 855,ERR(I),WRE(I),GE(I),GES(I),CCOST(I,1),COSTO(I,1),
     1ACOST(I,1),TCOST(I,1),ECF(I),AE(I)
855  FORMAT(24X,F5.3,5X,F3.1,5X,F4.0,7X,F4.1,4X,F7.2,3X,F7.2,3X,F7.2,
     13X,F7.2,2X,F3.1/20X,'AE'/21X,F6.1//)
      GO TO 20
  90  PRINT 900,I,CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),ECF(I)
900  FORMAT(1X,1HP,I2,2X,'PRELIMINARY',3X,'CCOST',5X,'COSTO',5X,
     1'ACOST',5X,'TCOST',5X,'ECF',/T7,'TREATMENT',5X,F7.2,3X,F7.2,3X,
     2F7.2,3X,F7.2,2X,F3.1,//)
      GO TO 20
110  PRINT 950,I,SBL(I),ASB(I),CCOST(I,1),COSTO(I,1),ACOST(I,1),
     1TCOST(I,1),ECF(I)
950  FORMAT(1X,1HP,I2,2X,'SLUDGE',7X,'SBL',7X,'ASB',7X,'CCOST',5X,
     1'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF',/6X,'BEDS',10X,F3.1,7X,
     2F7.0,3X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,2X,F3.1,//)
  20  CONTINUE
      PRINT 1007
      PRINT 975
975  FORMAT (/////49X,'TOTAL  PLANT  COST',//)
      PRINT 980,CCI,AF,CENG,CTRP,CTGO,CLAND,CCR
980  FORMAT(19X,'CCI',7X,'AF',8X,'ENG',7X,'CTRP',6X,'CTGO',6X,'CLAND',
     15X,'CCR',/19X,F5.3,5X,F6.4,4X,F5.3,5X,F5.3,5X,F5.3,5X,F5.3,
     25X,F4.2)
      PRINT 985,TOTCC,TACOST
985  FORMAT(//19X,'TOTAL CAPITAL COST = ',F10.2,' THOUSANDS OF DOLLARS
     1',//14X,'TOTAL AMORTIZATION COST = ',F7.2,' CENTS/ 1000 GALS.'//)
      PRINT 990,TCOSTO,TOTTC
990  FORMAT(21X,'TOTAL O + M COST = ', F7.2,' CENTS/ 1000 GALS.',//17X,
     1'TOTAL TREATMENT COST = ',F7.2,' CENTS/ 1000 GALS.')
      PRINT 995
995  FORMAT(1H1,30X,'THE END')
      RETURN
      END
```

CINCINNATI WATER RESEARCH LABORATORY
CALLING PROGRAM FOR WASTEWATER TREATMENT SYSTEM PREDLIMINARY DESIGN

SHEET 1

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC								PAGE OF
PROGRAMMER	DATE		PUNCH								CARD ELECTRO NUMBER*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
|---|---|---|---|---|---|---|---|---|---|---|---

CINCINNATI WATER RESEARCH LABORATORY
CALLING PROGRAM FOR WASTEWATER TREATMENT SYSTEM PRELIMINARY DESIGN

SHEET 2

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC								PAGE OF
PROGRAMMER	DATE		PUNCH	1							CARD ELECTRO NUMBER*

COST CONSTANTS STORED IN DMATX(I,20), I=1,16

CKWH	CCI	AF	CTRP	CTPO	CLAND	CFECLR	CCL2
•	•	•	•	•	•	•	•
•	•	•	•	•	•	•	•

K	N	PROCSS	IS1	IS2	OS1	OS2	III

DMATX(1,N)	DMATX(2,N)	DMATX(3,N)	DMATX(4,N)	DMATX(5,N)	DMATX(6,N)	DMATX(7,N)	DMATX(8,N)
•	•	•	•	•	•	•	•

DMATX(9,N)	DMATX(10,N)	DMATX(11,N)	DMATX(12,N)	DMATX(13,N)	DMATX(14,N)	DMATX(15,N)	ECF(N)
•	•	•	•	•	•	•	•

K	N	PROCSS	IS1	IS2	OS1	OS2	II

DMATX(1,N)	DMATX(2,N)	DMATX(3,N)	DMATX(4,N)	DMATX(5,N)	DMATX(6,N)	DMATX(7,N)	DMATX(8,N)
•	•	•	•	•	•	•	•

DMATX(9,N)	DMATX(10,N)	DMATX(11,N)	DMATX(12,N)	DMATX(13,N)	DMATX(14,N)	DMATX(15,N)	ECF(N)
•	•	•	•	•	•	•	•

K	N	PROCSS	IS1	IS2	OS1	OS2	III

DMATX(1,N)	DMATX(2,N)	DMATX(3,N)	DMATX(4,N)	DMATX(5,N)	DMATX(6,N)	DMATX(7,N)	DMATX(8,N)
•	•	•	•	•	•	•	•

DMATX(9,N)	DMATX(10,N)	DMATX(11,N)	DMATX(12,N)	DMATX(13,N)	DMATX(14,N)	DMATX(15,N)	ECF(N)
•	•	•	•	•	•	•	•

*A standard card form, IBM electro 888157, is available for punching statements from this form

CINCINNATI WATER RESEARCH LABORATORY
CALLING PROGRAM FOR WASTEWATER TREATMENT SYSTEM PRELIMINARY DESIGN

PROGRAM | PUNCHING INSTRUCTIONS | GRAPHIC | PUNCH | SHEET 3 | PAGE OF | CARD ELECTRO NUMBER*

PROGRAMMER | DATE

K	N	PROCSS	IS1	IS2	OS1	OS2	III

DMATX(1,N)	DMATX(2,N)	DMATX(3,N)	DMATX(4,N)	DMATX(5,N)	DMATX(6,N)	DMATX(7,N)	DMATX(8,N)
•	•	•	•	•	•	•	•
DMATX(9,N)	DMATX(10,N)	DMATX(11,N)	DMATX(12,N)	DMATX(13,N)	DMATX(14,N)	DMATX(15,N)	ECF(N)
•	•	•	•	•	•	•	•

K	N	PROCSS	IS1	IS2	OS1	OS2	III

DMATX(1,N)	DMATX(2,N)	DMATX(3,N)	DMATX(4,N)	DMATX(5,N)	DMATX(6,N)	DMATX(7,N)	DMATX(8,N)
•	•	•	•	•	•	•	•
DMATX(9,N)	DMATX(10,N)	DMATX(11,N)	DMATX(12,N)	DMATX(13,N)	DMATX(14,N)	DMATX(15,N)	ECF(N)
•	•	•	•	•	•	•	•

K	N	PROCSS	IS1	IS2	OS1	OS2	II

DMATX(1,N)	DMATX(2,N)	DMATX(3,N)	DMATX(4,N)	DMATX(5,N)	DMATX(6,N)	DMATX(7,N)	DMATX(8,N)
•	•	•	•	•	•	•	•
DMATX(9,N)	DMATX(10,N)	DMATX(11,N)	DMATX(12,N)	DMATX(13,N)	DMATX(14,N)	DMATX(15,N)	ECF(N)
•	•	•	•	•	•	•	•

K	N	PROCSS	IS1	IS2	OS1	OS2	III

DMATX(1,N)	DMATX(2,N)	DMATX(3,N)	DMATX(4,N)	DMATX(5,N)	DMATX(6,N)	DMATX(7,N)	DMATX(8,N)
•	•	•	•	•	•	•	•
DMATX(9,N)	DMATX(10,N)	DMATX(11,N)	DMATX(12,N)	DMATX(13,N)	DMATX(14,N)	DMATX(15,N)	ECF(N)
•	•	•	•	•	•	•	•

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

* A standard card form, IBM electro 888157, is available for punching statements from this form

SAMPLE PROGRAM PRINTOUT

INPUT DATA

K	N	PROCESS	IS1	IS2	OS1	OS2	III
0	7	PREL	1	0	3	0	2
1	0	MIX	3	9	20	0	1
0	1	PRSET	20	0	2	8	0
0	2	AERFS	2	0	5	7	0
0	0	SPLIT	5	0	50	17	0
0	0	MIX	7	8	10	0	0
0	3	THICK	10	0	12	11	0
0	4	DIG	12	0	13	0	0
0	5	ELUT	13	17	15	14	0
0	6	VACF	15	0	18	16	0
0	0	MIX	11	14	21	0	0
1	0	MIX	16	21	9	0	1
9	0		0	0	0	0	0

STREAM CHARACTERISTICS

VOLUME FLOW, MILLIONS OF GALLONS PER DAY
CONCENTRATIONS, MILLIGRAMS/LITER

S 1.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	10.000	105.000	30.000	10.000	2.000	30.000	140.200	223.600
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	250.000	43.000	11.000	19.100	4.000	500.000	59.840	253.600
S 2.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	10.277	53.324	15.403	5.142	1.007	15.313	70.956	113.787
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	265.470	42.438	11.000	23.376	4.846	500.000	58.789	141.300
S 3.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	10.000	105.000	30.000	10.000	2.000	30.000	140.200	223.600
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	250.000	43.000	11.000	19.100	4.000	500.000	59.840	253.600
S 5.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	10.113	9.045	4.047	1.494	0.090	3.174	10.046	21.526
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	265.470	12.582	11.000	21.310	5.417	500.000	2.959	24.700
S 7.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.163	2184.708	977.524	360.880	21.847	766.650	2426.546	5199.605
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	265.470	12.582	11.000	21.310	5.417	500.000	2.959	5966.254
S 8.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.013	42605.941	12307.211	4108.512	804.978	12235.289	56694.023	90916.187
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	265.470	42.438	11.000	23.376	4.846	500.000	58.789	112898.687
S 9.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.290	158.803	57.279	19.635	2.442	50.893	194.721	354.675
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	799.444	23.044	11.000	170.974	34.047	499.999	22.522	1271.047
S10.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.176	5134.266	1804.257	634.346	78.993	1603.523	6386.469	11454.387
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	265.470	14.761	11.000	21.461	5.375	500.000	7.033	13769.168
S11.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.138	328.282	115.363	40.560	5.051	102.528	408.348	732.388
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	265.470	14.761	11.000	21.461	5.375	500.000	7.033	880.395

S12.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.038	22372.875	7862.156	2764.202	344.215	6987.445	27829.426	49913.187
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	265.470	14.761	11.000	21.461	5.375	500.000	7.033	60000.000
S13.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.038	8082.645	7862.156	1008.398	125.572	6987.445	412.313	19236.684
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	4339.809	84.497	11.000	1162.733	224.018	500.000	137.439	26224.129
S14.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.141	0.599	0.268	0.099	0.006	0.210	0.665	1.425
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	1284.055	30.561	11.000	306.666	60.067	499.999	36.579	1736.148
S15.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.013	18492.836	17988.363	2307.182	287.304	15987.055	943.359	44012.926
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	1284.055	30.561	11.000	306.666	60.067	499.999	36.579	60000.000
S16.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.011	61.643	59.961	7.691	0.958	53.290	3.145	146.710
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	1284.055	30.561	11.000	306.666	60.067	499.999	36.579	200.000
S17.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.115	9.045	4.047	1.494	0.090	3.174	10.046	21.526
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	265.470	12.582	11.000	21.310	5.417	500.000	2.959	24.700
S18.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.0	1960.720	1907.233	244.621	30.462	1695.042	100.021	4666.508
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	136.143	3.740	1.166	32.514	6.369	53.013	3.878	6361.559
S20.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	10.290	106.515	30.768	10.271	2.012	30.568	141.735	227.290
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	265.470	42.438	11.000	23.376	4.846	500.000	58.789	282.247
S21.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	0.279	162.613	57.174	20.104	2.500	50.799	202.233	362.830
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	780.443	22.749	11.000	165.654	33.026	499.999	21.970	1313.043
S50.	Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
	9.998	9.045	4.047	1.494	0.090	3.174	10.046	21.526
	ALK	DOC	DNBC	DN	DP	DFM	DBOD	TSS
	265.470	12.582	11.000	21.310	5.417	500.000	2.959	24.700

PROCESS CHARACTERISTICS

CCOST=CAPITAL COST,THOUSANDS OF DOLLARS
COSTO=OPERATING + MAINTENANCE COST, CENTS/1000 GAL.
ACOST=AMORTIZATION COST, CENTS/1000 GAL.
TCOST=TOTAL TREATMENT COST, CENTS/1000 GAL.

P 1	PRIMARY SETTLER	FRPS	URPS	GPS	APS	CCOST	COSTO	ACOST	TCOST	ECF
		0.500	400.	1375.2	14.964	314.90	0.67	0.58	1.26	2.0

P 2	AERATOR FINAL SETTLER	BOD2	BOD5	DEGC	CAER20	DO	DOSAT	AEFF20	URSS	XRSS	* AFS
		129.7	13.0	20.	1.000	1.	10.8	0.050	3.00	0.0124	15.11
		GSS	CAER	CEDR	VAER	VNIT	MLSS	MLASS	MLBSS	MLXBSS	
		2000.	1.000	0.125	2.307	2.516	2000	871	264	547	
		MLOSS	MLISS	FOOD	RTURN	CNIT	CKWH	AIRCFD	BSIZE	CFPGAL	
		62	255	111.6	0.470	0.321	0.010	9539832.	9937.	0.93	

	ECF	CCOST	COSTO	ACOST	TCOST
AERATOR	1.2	677.79	1.24	1.25	2.49
BLOWER	1.5	104.45	0.52	0.19	0.71
SLUDGE PUMPS	2.0	22.05	0.0	0.04	0.04
FINAL SETTLER	2.0	294.88	0.0	0.54	0.54

P 3	THICKNER	TRR	GTH	GSTH	ATHM	CCOST	COSTO	ACOST	TCOST	ECF
		0.950	750.	9.0	3370.	126.28	0.0	0.23	0.23	1.5

P 4	DIGESTER	TD	TDIG	C1DIG	C2DIG	CCOST	COSTO	ACOST	TCOST	ECF
		15.0	33.0	0.261	854.98	274.41	0.34	0.51	0.85	2.0
		VDIG	CH4CFD	CO2CFD						
		154.1	89538.	47023.						

P 5	ELUTRIATE	ERR	WRE	GE	GES	CCOST	COSTO	ACOST	TCOST	ECF
		0.760	3.0	800.	9.0	121.77	0.0	0.22	0.22	1.5
		AE								
		1399.1								

P 6	VACUUM FILTER	VFL	TVF	CFECL3	FECL3	CCOST	COSTO	ACOST	TCOST	ECF
		4.9	0.238	0.080	3.1576	240.10	0.99	0.44	1.43	1.0
		WP	AVF	CCHEM						
		70.6	390.6	5881.						

P 7	PRELIMINARY TREATMENT	CCOST	COSTO	ACOST	TCOST	ECF
		94.15	0.28	0.17	0.45	1.0

TOTAL PLANT COST

CCI	AF	ENG	CTRP	CTGU	CLAND	CCR
1.130	0.0674	0.074	0.100	0.150	0.020	1.34

TOTAL CAPITAL COST = 2280.14 THOUSANDS OF DOLLARS

TOTAL AMORTIZATION COST = 4.21 CENTS/ 1000 GALS.

TOTAL O + M COST = 4.03 CENTS/ 1000 GALS.

TOTAL TREATMENT COST = 8.24 CENTS/ 1000 GALS.

ENDORSED